



## OPTICAL DEVICE

Michael D. GOLDSTEIN, Avi YARON and Shay GHILAI

### FIELD OF THE INVENTION

5           The present invention relates to endoscopes, microscopes and boroscopes, in general and to stereoscopic image pick up devices with color imaging capability, in particular.

### BACKGROUND OF THE INVENTION

10           Stereoscopic image detection devices are known in the art. Such devices are required to obtain and provide a combination of small cross section and high image quality. It will be appreciated by those skilled in the art that high image quality, in general, is characterized by stereoscopic vision accuracy, color capabilities, high resolution and illumination  
15 requirements.

          It is noted that conventional methods, which provide stereoscopic images, require a wider optical path than a monocular one. Such a widened optical path enlarges the cross-section required for the detection device considerably. Hence, the requirement for a small cross  
20 section is not maintained.

          US Patent No. 5,527,263 to Zobel et al., is directed to a dual optical path stereo endoscope with simple optical adjustment. US Patent No. 5,776,049 to Takahashi, is directed to a "Stereo Endoscope in Stereo Endoscope Imaging Apparatus" and provides a device which utilizes a  
25 combination of two optical paths with two CCD units, capable of variable zoom.

          Auto-stereoscopic devices, which utilize one optical system to provide a stereo effect, are also known in the art. Such a device is provided in US patent No. 5,603,687 to Hori, which is directed to a device  
30 with two parallel optical axes and two CCD elements. Hori selected an

asymmetrical approach, wherein one optical channel has a large aperture for light and details, and the other optical channel provides a parallax image for stereoscopic imagery to the proximal CCD.

US patent No. 5,613,936 to Czarnek, is directed to a  
5 stereoscopic endoscope device which utilizes light polarization and time multiplexing, in order to transmit each different polarized image corresponding to left and right images multiplexed in time, through one optical channel that transfers images from the lateral side of the endoscope shaft. This endoscope has to be inserted deeper into the  
10 human cavity to receive a stereo image. It must also be used with a head mounted display device called "switched shutter glasses" that causes eye irritation. It is noted that according to Czarnek each image is received in 25% of original quality. As much as 50% of the light received from the object, is lost due to polarization considerations and as much as 50% of  
15 the remaining information is lost due to channel switching.

US patent No. 5,588,948, to Takahashi et al., is directed to a stereoscopic endoscope. The stereo effect is produced by having a dividing pupil shutter, which splits the optical path onto the left and right sides, and the up and down sides. These sides are alternately projected  
20 on a proximal image pick up device, using time multiplexing. According to another aspect of this reference a distal CCD is included, which is divided to left and right sides with a shading member separating them, for achieving space multiplexing.

U.S. patent No. 5,743,847 to Nakamura et al., is directed to a  
25 "Stereoscopic Endoscope Having Image Transmitting Optical-System and Pupil Dividing Unit that are Axially Movable With Respect to Each Other", which uses a plural pupil dividing means and one optical channel. U.S. patent No. 5,751,341 to Chaleki et al., is directed to a "Stereoscopic Endoscope System", which is basically a two channel endoscope, with one